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ABSTRACT

The study involving 60 learning disabled (LD) children (7-10 years old) was designed tc determine if LD children go beyond the given information when trying to understand and remember sentences, i.e., do they spontaneously construct inferential relationships like adults and other children, or do they attend to and rehearse individual sentences of specific sentence constituents. In addition to assessing memory strategies, two types of sentences (highly imageable versus not easily imaged) were presented to determine whether or not semantic integration by these children was related to, or facilitated by, image factors. Further, developmental changes in the use of integrative skills were analyzed. The mode of storage, or the performance of integration, was measured by testing the children's abilities to recognize sentences which were never actually presented, but could be derived through a ccmprehension of relationships among semantically related sentences. Results indicated that normal children spontaneously integrate the information expressed by a number of nonconsecutively presented, but semantically related, sentences; LD children do not. ID children appeared to attend to smaller units, short sentences, as well as words. (SBH)

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Psycholinguistic research has suggested that memory for sentences is basically an "interpretive," "integrative" process. The present study was designed to investigate how learning disabled children retain information.

"Integration," in general, is a process of combining independently represented, yet functionally related stimuli into a single organized unit. Integration is a generic term for an operation by which information is succinctly stored. The concept of "semantic integration" originated from research on how adults remember sentences. It has been shown that adults do not remember individual sentences or words, but instead they integrate semantic relationships from a given context (Bransford & Franks, 1971; Franks & Bransford, 1972; Bransford, Barclay, & Franks, 1972; Barclay, 1973). Bransford and Franks (1971) showed that it is the "meaning" of the sentence which is remembered, not the sentence itself. In addition, the meaning of sets of sentences dealing with the same idea was integrated into a single representation and included all of the information contained in the several members of the set. It was that single representation which was retained in memory.

Constructive Aspects of Children's Memory

There has been little research with children's sentence memory. According to Paris (1970), in his research with children,

"semantic integration" is taken to be an active strategy of comprehension of sentences which includes expanding of explicit information through inferential operations and combining these constructed relationships. In other words, this constructive elaboration simplifies access to information, while integration provides efficiency of storage. The ability to elaborate or make inferences and integrate ideas allow children to know the information more completely. Both are contingent upon the child's past experiences and knowledge of the environment.

Collectively, studies by Paris and Carter (1973, Paris and Upton (1974), Paris and Lindauer (1976) indicated that children constructed inferential relationships and integrated these relationships in their effort to comprehend and remember information. To date, however, few known underying causes of specific learning difficulties have been researched in order to provide functional remedial techniques. Therefore, it seemed worthwhile to examine the possibility that deficient semantic integration contributes to learning problems in some children. A limited amount of empirical evidence concerning the processes involved is available in terms of the learning disabled population. New concepts and constructs are needed to better understand the developmental aspects of information processing in learning disabled children.

It was the goal of this research to determine if learning disabled children go beyond the given information when trying to understand and remember sentences, i.e., do

they spontaneously construct inferential relationships like adults and other children, or do they attend to and rehearse individual sentences or specific sentence constituents. The experimental design used was similar to that of Bransford and Franks (1971) and Franks and Bransford (1972). In addition to assessing memory strategies of learning disabled children, this study presented two types of sentences (highly imageable versus not easily imaged) in order to determine whether or not semantic integration by these children was related to, or facilitated by, image factors. Further, developmental changes in the use of integrative skills were analyzed.

PROCEDURE

Subjects

Experimental subjects included sixty children (thirty girls and thirty boys) classified as learning disabled by a psychoeducational diagnostic team consisting of a speech and language evaluator, an educational evaluator, and a psychologist.

Criteria for subject selection as learing disabled were:

(1) educational test scores in two or more academic areas two years below grade level,

(2) language test results within one standard deviation from the mean for the various tests administered (it should be noted that on the current language measures available, learning disabled children do not exhibit gross linguistic deficiencies, and despite their more subtle learning and language problems, tend to fall within normal limits),

(3) auditory acuity within normal limits,

(4) psychometric evaluation WISC Verbal Scale IQ score above 85,

(5) evidence of organicity.

The experimental subjects ranged in age from 7 years 0 months to 10 years 11 months.There were fifteen subjects in each of the following age groups:

(1) 7 years 0 months - 7 years 11 months

(2) 8 years 0 months - 8 years 11 months

(3) 9 years 0 months - 9 years 11 months

(4) 10 years 0 months - 10 years 11 months

These subjects were either attending or awaiting placement in coed special education classes in New York City public schools. They were predominantly from middle-class socioeconomic backgrounds.

Control subjects consisted of sixty normal children (thirty girls and thirty boys). They were chosen by their respective classroom teachers. Criteria for selection was appropriate grade level performance in all academic areas. Consultation with teachers and principal ruled out potential subjects with any history of special education or related learning problems.

Control subjects ranged in age from 7 years 0 months to 10 years 11 months with fifteen subjects per age range corresponding to experimental groups. There subjects attended grades two through five of a predominantly middle-class regular day elementary New York City public school.

Method

The experimental design consisted of three sections. A separate set of sentences was constructed for each section. Sections I, II, and III each had two parts. Part 1 was an incidental learning procedure in which subjects were presented with a list of sentences, one by one. A question followed each sentence. Subjects were required to answer the question about the sentence before the next sentence was presented. This procedure continued for all sentences of Part 1. Subjects were not told that they were later going to be tested on the sentences, nor that they would be integrating the meanings of the sentences presented. During Part 2 of each section subjects were presented with another list of sentences and asked whether they had heard those sentences before. Section III was a control task to determine the general ability of the subjects to answer questions about sentences and to recognize a list of eight sentences.

Apparatus and Instructions

All sentences for Parts 1 and 2 were prerecorded on a portable Channel Master audio tape recorder (model 6394) using TDK SD-60 tape cassettes. Specific instructions presented by the examiner prior to administering Part 1 sentences were:

> You are going to hear a list of sentences. After each sentence you are going to hear a question about that sentence, and I want you to tell me the answer.

The recorder was stopped long enough for the subject to respond to the question.

After Part 1 was completed, Part 2 instructions were given by the examiner as follows:

> You are going to hear another list of sentences. Some of the sentences are the same and some are different from the sentences you just heard. I want you to tell me if you heard the sentences before, or if you did not hear them. Tell me "yes" if you heard it before, "no" if you did not. Listen carefully because the sentences will not be repeated.

Testing Procedure

Specifically, Section I consisted of two complete idea sets in sentences which were imageable (i.e., CONCRETE). For each of these complete sentences, the meaning could be summarized into one organized unit. For example, the two complete sentences were:

"The big bear ate the chocolate candy in the woods."
"The old farmer milked the brown cow in the barn."

Each complete sentence was composed of four basic propositional units. Sentences, each expressing only part of the meaning of one of the complete ideas, were formed. Those expressing one of the basic propositions were called ONES, as the following sentences:

The bear was big.
The bear ate the candy.
The candy was chocolate.
The bear was in the woods.

And:

The farmer was old.
The farmer milked the cow.
The cow was brown.
The cow was in the barn.

Correspondingly, the complete sentences containing all four interrelated basic propositional units were called FOURS. Additional sentences such as the above were constructed by combining ONES into combinations of two propositional units called TWOS, as the following sentences:

The big bear ate the candy (which consists of "The bear was big" and "The bear ate the candy").

The old farmer milked the cow (which consists of "The farmer was old" and "The farmer milked the cow").

Three propositional units call THREES were constructed,

as the following sentences:

The big bear ate the chocolate candy.
The old farmer milked the cow in the barn.

In addition, NONCASE sentences were constructed. A NONCASE sentence is a sentence whose meaning is not derivable from one of the complete ideas being presented. Two types of NONCASES were formed: (1) TYPE I--a false inference, in which the combination of propositions of complete ideas is incorrect (e.g. "The farmer ate the chocolate candy in the barn"); and (2) TYPE II--a sentence whose idea is not related to either of the complete ideas, however contains a similar lexical item as one of the complete ideas (for example, "The cow ate the grass"). NONCASES were one (ONE), two (TWO), three (THREE) and four (FOUR) proposition sentences.

Part 1 of Section I contained eight sentence--two ONES, one TWO, and one THREE related to each of the two complete sentences. Sentences were chosen so that, as a group, they included all the information contained in each complete idea. The sentences, which were taped, were presented individually to each subject (experimenter controlled stopping and starting of the audio tape recorder as previously discussed). Each sentence was followed by a question, read by the experimenter, about that sentence. For example, for the sentence, "The cow was brown," the question, "What color was the cow?" followed. The response from the subject would be, "brown." Questions were selected so that each constituent of each complete sentence was questioned for all eight sentences in Part 1. Subjects were not told that there would be a second part to the experiment.

Subjects were given a one- to two-minute break after Part 1 was completed. They were then told that they would now hear another set of sentences, all of which were related to the sentences they just heard during Part 1. Their task was to indicate by saying "yes" or "no" which of the sentences they heard before and which ones they had not.

Part 2 contained three general types of sentences: eight old sentences (OLDS); eight new sentences (NEWS); and eight NONCASES (four each for TYPE I and TYPE II). OLDS were sentences actually presented during Part 1, including two ONES, one TWO, and one THREE related to each of the two ideas. NEWS were sentences whose meanings were derivable from one of the complete ideas (by combining the meaning of the set of sentences dealing with the same idea), however they were not actually presented during Part 1. NEWS consisted of one ONE, one TWO, one THREE, and one FOUR (the complete sentence). Finally, eight NONCASES were included--one ONE, one TWO, one THREE, and one FOUR for each of the two types of NONCASES previously described. Thus, Part 2 consisted of twenty-four sentences.

The order of presentation was similar to that of Part 1. The sentences were randomized with the constraint that no two sentences related to a given idea appear consecutively in the lists.

The general TYPES (OLDS, NEWS, and NONCASES), as well as the number of sentences used, were similar for Section II

of the experiment. However, Section II consisted of two complete sentences in which the verbal units could not easily be summarized or transformed into a nonverbal unit, i.e., they were not easily imaged (ABSTRACT). For example, the two complete (FOURS) ideas for Section II were:

"The smart children did not understand the important new rules."

"The proud poor people were disappointed by the high taxes."

Other sentences related to each complete idea, as well as NONCASES, were constructed as for Section I.

Section III was used as a control to determine the ability of children to answer questions about sentences and to recognize a list of eight sentences. Section III also consisted of two parts. During Part 1, the examiner presented each sentence to each subject followed by a question about that sentence. Subjects were also required to respond to each question. The eight sentences were totally unrelated to each other. The list consisted of sentences composed of one (ONE), two (TWO), three (THREE) and four (FOUR) propositons (two of each for a total of eight sentences).

Part 2 consisted of presenting another list of sentences to each subject. After each sentence subjects were instructed to respond "yes" or "no" as to whether it was heard before. The list of sentences for Part 2 was composed of five OLDS, i.e., sentences presented during Part 1 (one ONE, one TWO, two THREES , and one FOUR), and three NONCASES--one FOUR which was completely novel and unrelated to Part 1

sentences, and one ONE and one TWO which were related to Part 1 sentences only in terms of a repeated lexical item.

The presentation of Sectons I, II, and III was randomized.

Summary

It is important to initially discuss the type of performance pattern that constitutes semantic integration. Within the limitations of the present study, semantic integration occurs when subjects respond in the following way: (1) NEW sentences should receive positive or "yes" ratings because they are derivable from the complete idea (i.e., all the information given) which has been stored. Subjects should think they heard NEW sentences even though they did not actually hear them before. Such responses are called "false positives"; (2) both types of NONCASES should receive negative or "no" responses because they are not derivable from the complete idea. NONCASE data are very important for interpreting results. TYPE I NONCASES would show that subjects were not just responding to sentence length or complexity, inasmuch as they are just as long and complex as any of the clear cases. TYPE II NONCASE results would also suggest that subjects were not merely responding on the basis of key words heard in the Part 1 sentences given. This ability to distinguish subtle differences in sentences suggests precise discrimintion of semantic information remembered; (3) OLDS and NEWS should receive similar "yes" responses since responses are based on combined information of a sentence set, not just individual sentences actually heard.

RESULTS

All data reported were in terms of the mean number of "yes" responses to sentences presented. The raw data used was the actual number of "yes" responses to each sentence presented.

The following between and within subject variables and levels of the variables were referred to by these labels:

Between subject variables:

CATEGORY - (2 levels) LD/NORMAL

AGE - (4 levels) 7/8/9/10 years

Within subject repeated measures:

IMAGE - (2 levels) CONCRETE/ABSTRACT

TYPE - (3 levels) OLD/NEW/NONCASE

NONCASES - (2 levels) TYPE I NON/TYPE II NON

ELEMENTS - (4 levels) ONE/TWO/THREE/FOUR

An analysis of variance was computed for the following variables across the repeated measures: CATEGORY X AGE X IMAGE X TYPE (OLD/NEW/NON). As there was a total of eight sentences per sentence IMAGE/TYPE, the maximum number of "yes" responses was eight. There was no main effect for AGE across varialbes. Results indicate a significant difference between the mean number of "yes" responses for LD (Learning Disabled) and NORMAL children (F = 16.401, df = 1,112, p = $<$.001). Figure 1 shows a significant CATEGORY X TYPE interaction (F = 52.75, df = 2,224, p = $<$.001). LD children responded "yes" a significantly greater number of times for OLDS (p = $<$.005)

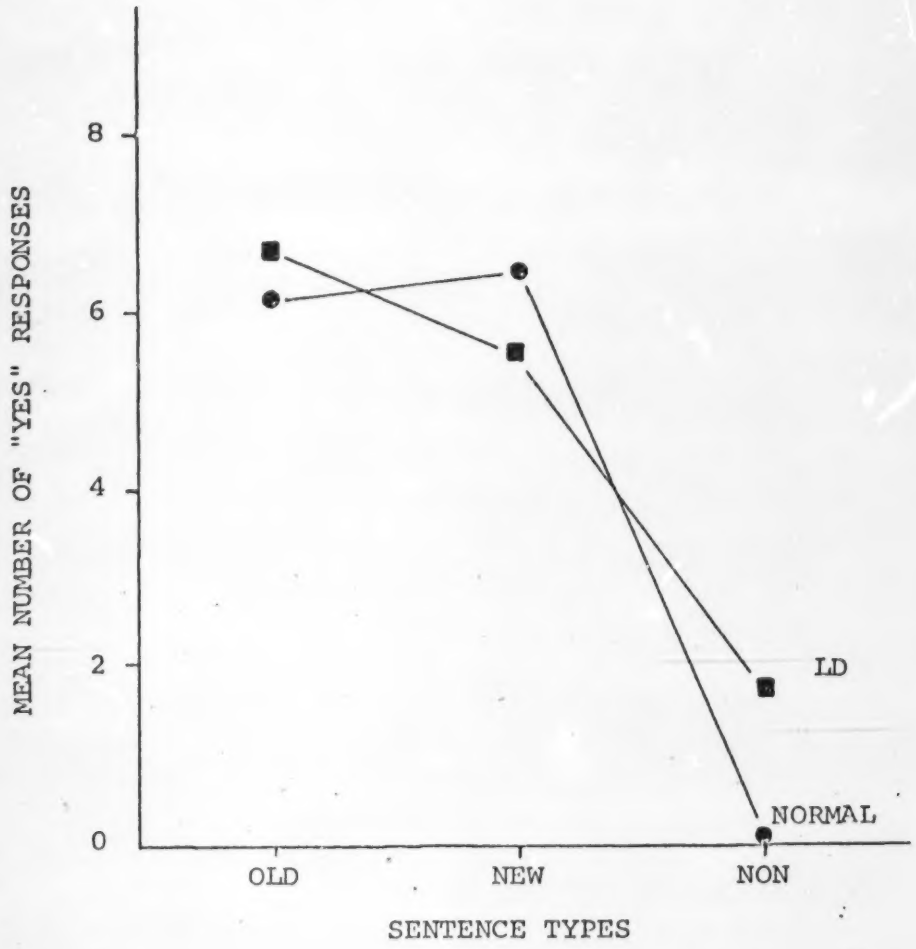

Fig. 1. Mean Number of "Yes" Responses to OLD, NEW, and NONCASE Sentences by Learning Disabled and Normal Children (CATEGORY X TYPE INTERACTION).

and NONS ($p < .001$) than did NORMALS, with a significant drop for NEWS ($p < .002$). In addition, a planned comparisons of the means indicated that LD children scored higher for OLDS than NEWS ($p < .001$), whereas for NORMALS the mean number of "yes" responses for OLDS and NEWS was not significantly different (i.e., OLDS = NEWS).

For both CATEGORIES (LD/NORMAL) the total number of "yes" responses to OLD + NEW TYPES differed from NONS, accounting for the TYPE main effect ($F = 1228.054$, $df = 2,224$, $p < .001$), and the IMAGE X TYPE interaction ($F = 14.329$, $df = 2,224$, $p < .001$). The IMAGE effect ($F = 7.873$, $df = 1,112$, $p < .005$) revealed, on the average, a greater number of "yes" responses for CONCRETE than for ABSTRACT sentence types.

Figure 2 shows a significant CATEGORY X TYPE X IMAGE interaction ($F = 14.185$, $df = 2,224$, $p < .001$). The number of "yes" responses of learning disabled children consistently and significantly decrease for every sentence TYPE, regardless of IMAGE (OLDS > NEWS > NONS). NORMAL children, on the other hand, do not distinguish OLD and NEW CONCRETE sentences, but score higher (greater number of "yes" responses) on NEW ABSTRACTS than OLD ABSTRACTS. In addition, LD children have the lowest score for NEW ABSTRACTS as compared to other combinations of IMAGE X TYPE.

In order to make appropriate comparisons within levels of the variables, a number of smaller analyses were done. While it is known that there are not enough degrees of freedom for multiple analyses, they were carried out

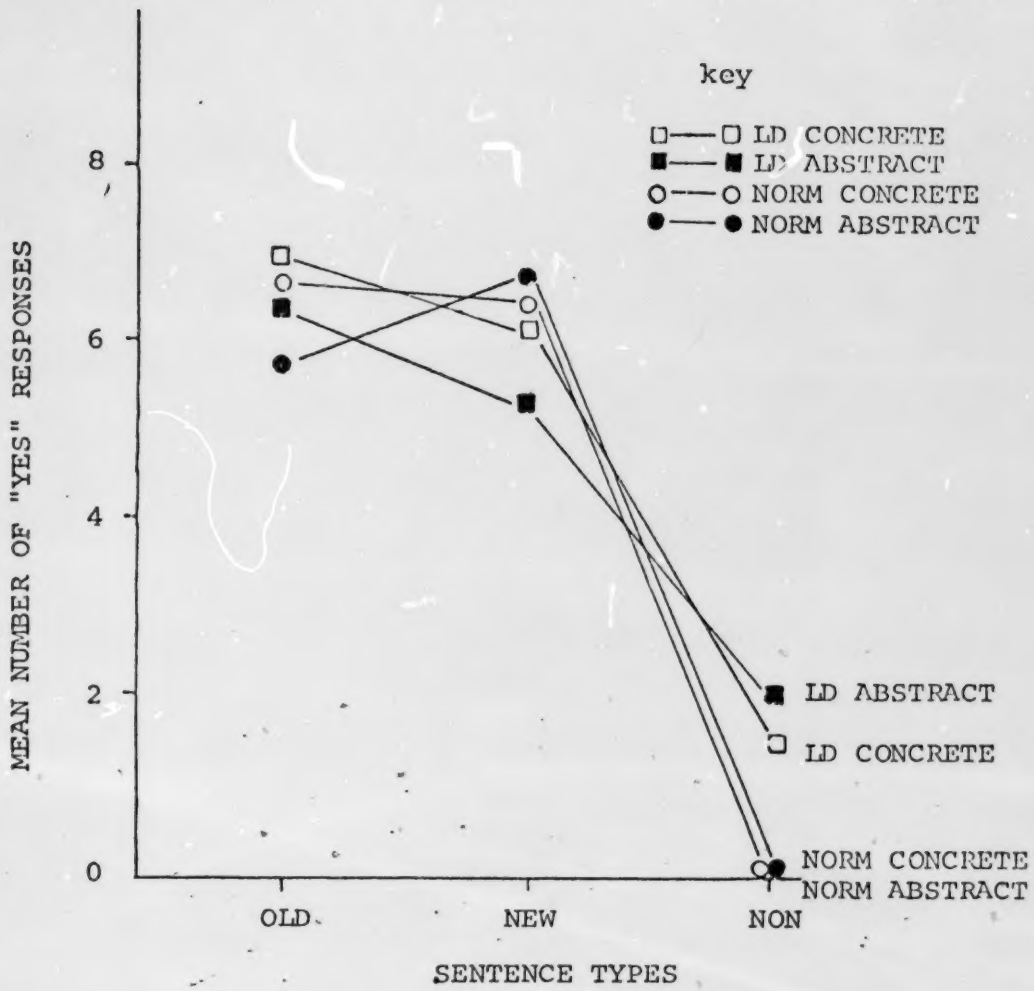

Fig. 2. Mean Number of "Yes" Responses by Learning Disabled and Normal Children as a Function of Sentence TYPE and IMAGE (CATEGORY X TYPE X IMAGE INTERACTION).

for a more complete picture of the results. It is further justified in view of the fact that so many interactions were significant.

A separate analysis of variance was computed for the variables CATEGORY X IMAGE X TYPE (OLD/NEW) X ELEMENTS (ONE/TWO/THREE). The number of responses were averaged across two per element (thus two was the maximum number of "yes" responses recorded). Also NEW FOURS were eliminated from this analysis inasmuch as there were no OLD FOURS for comparison. However, the NEW FOURS were subsequently analyzed fro all categories and combined with the following results.

There were no significant AGE or CATEGORY main effects across ONE, TWO, and THREE element sentences. The significant main effects were for IMAGE (F = 16.238, df = 1.112, p = <.001); TYPE (F= 80.240, df = 1,112, p = <.001); and ELEMENTS (F = 169.764, df = 2,224, p = <.001).

Figure 3 shows that on the average, for all children, the mean number of "yes" responses are ordered such that: CONCRETE> ABSTRACT, OLDS> NEWS, THREES> TWOS> ONES.

Figure 4 distinguishes between the performance of the LD and NORMAL children, showing the significant and extremely important CATEGORY X ELEMENT interaction (F = 45.138, df = 2,224, p = <.001). Collapsing over OLDS/NEWS and CONCRETE/ABSTRACT sentences, for NORMALS, the increase in the mean number of "yes" responses is a function of the increase in the number of ELEMENTS per sentence. However, for LD children, the mean number of "yes" responses significantly increase from ONES to TWOS (p = <.001), remains the same from TWOS to THREES,

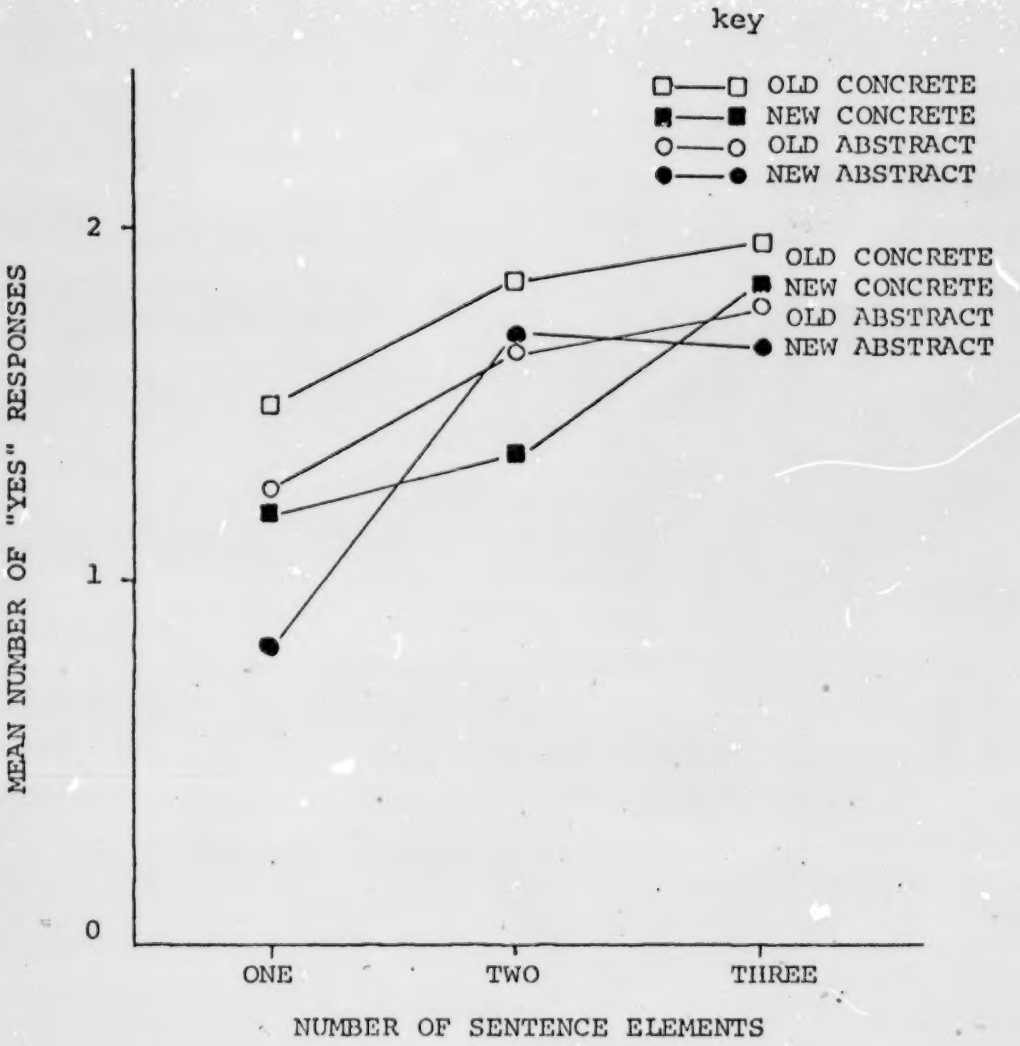

Fig. 3. Mean Number of "Yes" Responses by All Subjects as a Function of Sentence TYPE, IMAGE, and ELEMENT (IMAGE X ELEMENT X TYPE INTERACTION).

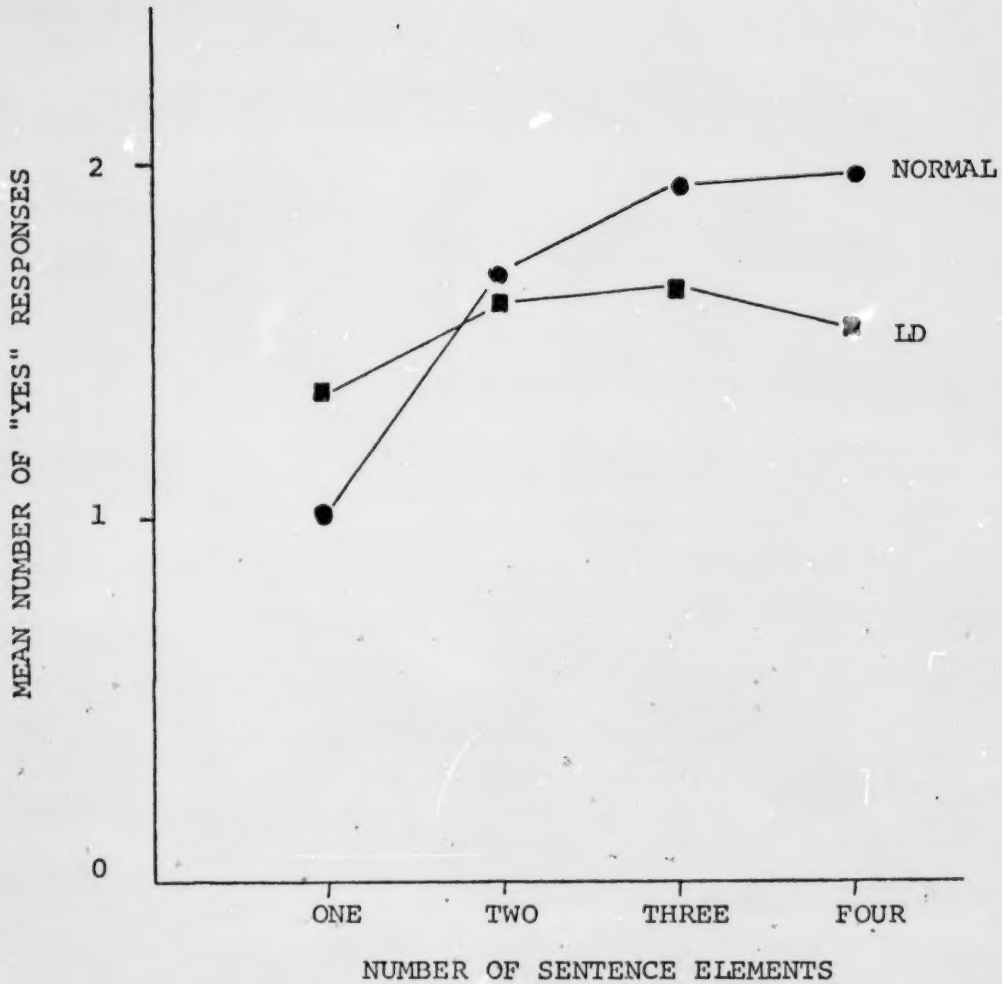

Fig. 4. Mean Number of "Yes" Responses by Learning Disabled and Normal Children as a Function of Sentence ELEMENTS (CATEGORY X ELEMENT INTERACTION).

and starts to decline from THREES to FOURS ($p < .01$). In addition, LD children scored significantly higher for ONES than did NORMALS, and converged at TWOS (the point at which the behavior of integration would start to occur). Then, the NORMALS significantly surpassed LD children at THREES ($p < .001$) and continued the significant rise to FOURS ($p < .001$).

The final set of data considered is for the NONCASES. TYPE I NONCASE contained combinations of elements (ONES) which were not consonant with any of the complete sentences; TYPE II NONCASES contained only a similar lexical item as those contained in the complete sentences. Data indicates that NORMAL children were quite sure that they had not heard NONCASE sentences. There was a significant CATEGORY main effect ($F = 91.634$, $df = 1,112$, $p < .001$) and CATEGORY X TYPE interaction ($F = 107.161$, $df = 1,112$, $p < .001$).

The LD children accounted for all "yes" responses for TYPES I and II NONCASES. There was a significant TYPE main effect ($F = 107.161$, $df = 1,112$, $p < .001$) -- LD children scoring higher on TYPE I than TYPE II NONCASES.

DISCUSSION

The present experiment was designed to determine whether learning disabled children, and normal children, would decode independently presented sentences as discrete events or would combine them into a more complex interrelating semantic system (via what has been defined as semantic integration). The mode of storage, or the performance of integration, was measured by testing the children's abilities to recognize sentences which were never actually presented, but could be derived through a comprehension of relationships among semantically related sentences.

Results of the experiment indicate that learning disabled and normal children significantly differ in terms of performance with respect to sentence TYPE, IMAGE and ELEMENT classifications. Data indicates that normal children consistently exhibited the behavioral response pattern indicative of semantic integration. They thought they "recognized" novel sentences (NEWS) consonant with the ideas presented, but were quite sure that they had not heard NONCASE sentences. In addition, they were most confident of having heard those sentences expressing all of the information characteristic of the complete complex sentence (FOUR); the mean number of "yes" responses were ordered FOURS $>$ THREES $>$ TWOS $>$ ONES, according to the semantic complexity of the sentences. The fact that normal subjects recognized NEW THREES and particularly NEW FOURS was important, inasmuch as these sentences contained combinations

of semantic relationships never actually presented. The information contained in the NEW THREES and FOURS could only have been learned by integrating information from various sentences actually presented. The fact that the number of responses for TWOS and ONES were lower than for FOURS and THREES suggests that subjects were less sure that they heard the former. However, nearly all subjects knew they heard some short sentences and thus each individual subject said "yes" to some of those sentences.

Whether a sentence was OLD or NEW had very little effect on response patterns of normal children. In general, normal children were unable to discriminate novel sentences (NEWS) never actually presented to them from sentences they had heard (OLDS).

The effect of imagery was inconsistent for normal children. In general, the IMAGE variable did not appear to facilitate their performance.

In comparison, performance of learning disabled children appear to indicate that information is often decoded into discrete semantic units, independent of an organized semantic system. Learning disabled children consistently and significantly discriminated OLD from NEW sentences, and recognized more OLD than NEWS as the sentences they heard. This occurred for both CONCRETE and ABSTRACT sentences. On the average, learning disabled children recognized a significantly greater number of CONCRETE as opposed to ABSTRACT, sentences across all other variables.

The fact that learning disabled children responded "yes" most frequently to OLD sentences types could initially be indicative of "trace memory processing." However, although the number of responses for OLD vs. NEW sentences was significant, the children still responded to a considerable number of NEW sentences which were never presented. Learning disabled children were also sure that they heard many TYPE I and TYPE II NONCASE sentences (with a greater number of "yes" responses to TYPE I).

The significant difference between learning disabled and normal children's responses to OLD and NEW sentences occurred at the level of ABSTRACT sentences. Performance was similar for both groups for CONCRETE OLDS and NEWS. Learning disabled children recognized more ABSTRACT OLD sentences as the ones they heard than did normal children; on the other hand, normal children recognized significantly more ABSTRACT NEW sentences than did learning disabled children.

Performance patterns in relation to the number of sentence ELEMENTS must be considered for appropriate comparisons. Learning Disabled children did not exhibit the observed ordering of elements as normals did. In fact, learning disabled children recognized significantly more ONES than normals. Similar performance occurred for both groups for TWOS, the point at which integration first appears. As normal children continued to integrate additional related information (at the point of THREES and FOURS), performance

of learning disabled children remained constant from TWOS to THREES, and started to decline at FOURS. This pattern was similar for both OLD and NEW sentences.

Summary

It is obvious from the results that normal children spontaneously integrate the information expressed by a number of nonconsecutively presented, but semantically related, sentences; learning disabled children do not. Learning disabled children appear to attend to smaller units, short sentences (ONES), as well as words (as demonstrated by their responses to NONCASES). In addition, their performance is similar to normals at the level of TWOS, where integration begins. Perhaps they can integrate up to a certain point, beyond which any additional information is in excess of their integrative capacities. Further, imagery appeared to have facilitated performance for learning disabled children, perhaps providing additional cues to organize and decode verbal information in holistic descriptions of situations.

It appears to be the case that learning disabled children did not adopt a decoding strategy similar to normal children. Such a strategy would have allowed for a more efficient processing of the information because a much smaller number of discrete events would then have to be remembered. Learning disabled children appeared to have attended to individual sentences as well as to specific sentence constituents in an attempt to remember information. They were not capable of abstracting semantic relationships in a manner qualitatively similar to normal children, but appeared to be functioning at the level when integration begins.

Educational Application

The principles underlying the experimental tasks presented are similar to the principles which underly children's everyday experience in school. They are required to comprehend and remember meaning from stories, films and teacher's instructions. Understanding and retaining the meaning of these various contextual events are the goals of the child's language processing.

It is feasible to speculate that academic training for learning disabled children does not directly enhance integrative abilities of these youngsters. Teachers are made aware of, and are taught to limit the amount of auditory-vocal stimulation presented to learning disabled children. These children are frequently exposed to explicit, discrete directives and verbalizations, as it is assumed that they are unable to handle more. The present experimental results suggest the need to change remedial procedures in order to maximize learning.

In the past there has been a division between basic and applied research in the study of developmentally related problems. The research carried out in this paper can be related to practical problems raised in an applied setting (e.g. the classroom).

There have been suggestions that learning disabled children are inadequate at integrative skills, and this paper has empirically investigated some of these processing deficiencies. Without this evidence, the outlook for the development of effective assessment strategies, and educational benefits from intervention programs might be limited.

Our research with learning disabled children is still far from a position where it can provide definitive answers to the nature of their integrative problems. However, by specifying the problems, additional effective research can be initiated within the broad domains of assessment and remediation. The present study was geared to providing basic information concerning learning and memory strategies of learning disabled children, as well as a foundation for future educational applications.

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